Rapid Evidence Product

Association Between Outcomes and Dental Services in People Receiving Treatment for Human Immunodeficiency Virus: A Rapid Response Review

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The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Preface

Recognized for excellence in conducting comprehensive systematic reviews, the Agency for Healthcare Research and Quality (AHRQ) is expanding its portfolio to include rapid evidence products. The program has begun to develop a range of rapid evidence products to assist end users in making specific decisions in a limited timeframe.

To shorten timelines, reviewers must make strategic choices about which processes to abridge. Common adaptations to provide rapid evidence include narrowly focusing questions, limiting the number of databases searched and/or modifying search strategies, using a single reviewer and/or abstractor with a second to provide verification, and restricting to studies published in the English language. However, the adaptations made for expediency may limit the certainty and generalizability of the findings from the review, particularly in areas with a large literature base. Transparent reporting of the methods used, the resulting limitations of the evidence synthesis, and the strength of evidence of included studies is extremely important. While tradeoffs will likely differ for each topic, they are described so readers can adjudicate the limitations of the findings and conclusions of the review.

AHRQ expects that these rapid evidence products will be helpful to health plans, providers, purchasers, government programs, and the healthcare system as a whole. Transparency and stakeholder input are essential to the Effective Health Care Program.

If you have comments on this report, they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Association Between Outcomes and Dental Services in People Receiving Treatment for Human Immunodeficiency Virus: A Rapid Response Review

Key Messages

Purpose of Review

This review is undertaken to answer the following questions:

Key Question 1: What is the effectiveness of dental services in improving health outcomes in people with human immunodeficiency virus (HIV) before, during, or after HIV treatment?

Key Question 2: What are the clinical practice guidelines or standards for dental care for people with HIV?

Key Messages:

- The body of evidence informing KQ1 is limited to three poor-quality single-arm studies evaluating the impact of non-surgical periodontal treatment (NSPT) in HIV-positive patients with periodontitis. Overall, the available data lack direct comparison and are at risk of selection and attrition bias, due to small and specific study populations and high dropout rates, respectively.
- All three studies found statistically significant increase in CD4 count from baseline after NSPT, while two reported no significant change in viral load from baseline after NSPT.
- Evidence on other HIV-related outcomes or adverse events associated with NSPT during antiretroviral therapy (ART) is unavailable.
- There are no studies on the effect of other dental services, nor the effect of dental treatment relative to timing of ART treatment.
- Eight guidelines with dental care practice recommendations for patients with HIV, from seven US-based professional organizations or government agencies and one India-based oral health expert group, consistently emphasize the importance of preventive oral care and include specific strategies to manage common HIV-related oral disease concerns, such as xerostomia, acid reflux, tooth decay, and periodontal disease.
- Guidelines encourage collaboration between primary care providers and dental providers to optimize the management of oral health for patients with HIV.

Contents

1. Background

Human immunodeficiency virus (HIV) is an infection that attacks the body's immune system, specifically targeting CD4 T lymphocyte cells. It spreads through sexual contact, exposure to infected blood (i.e., needle sharing) and, less commonly, from mother to child during pregnancy, childbirth, or breastfeeding. Initial infection often presents as flu-like symptoms or no symptoms at all and is characterized by a large viral load within a few weeks of contact with the virus. This acute stage of HIV is followed by a chronic or clinical latent stage where the virus continues to damage the immune system and can be marked without symptoms. When untreated, HIV progresses to an increasingly compromised immune state characterized by opportunistic fungal, bacterial, and viral infections, and eventually to acquired immune deficiency syndrome (AIDS).[1]

The U.S. Department of Health and Human Services estimates that 1.2 million people in the U.S. currently live with HIV.[2] While annual infections have decreased since the epidemic's peak in the early 1990s, the rate of new infections remains concerning, with approximately 31,800 new cases in the U.S. in 2022 alone.[2] HIV disproportionally affects historically vulnerable populations, including racial and ethnic minorities, gay, bisexual, and other men who have sex with men, people who inject drugs, and transgender people, especially, transgender women.[2,3,4] In 2022, men who have sex with men made up 67% of new cases and 87% amongst men in total with new infections. Black/African and Hispanic/Latino Americans accounted for more than half of the infections at 70%.[2] Geographically, southern states experienced higher rates of new cases.[2]

While there is no cure for HIV, antiretroviral therapies (ART) can significantly reduce viral load, decrease transmission, and delay progression to AIDS, especially when initiated early. Effective treatment often calls for a combination of three or more HIV treatment regimens from at least two different HIV drug classes to suppress viral load to an undetectable level.[5] FDA-approved medications for HIV include nucleoside reverse transcriptase inhibitors, non-nucleoside reverse transcriptase inhibitors, protease inhibitors, fusion inhibitors, CCR5 antagonists, integrase strand transfer inhibitors, attachment inhibitors, post-attachment inhibitors, capsid inhibitors, and pharmacokinetic enhancers.[6]

People with HIV face a higher risk of oral health problems due to their compromised immune systems, leading to a greater incidence and severity of dental diseases as compared to the general population.[7,8] Common issues include chronic dry mouth (xerostomia), gum disease (gingivitis), bone loss around the teeth (periodontitis), canker sores (aphthae), oral warts, fever blisters, thrush (oral candidiasis), hairy leukoplakia, and dental caries.[7] Oral lesions and similar conditions can serve as early indicators of HIV soon after seroconversion and may remain prevalent throughout the infection's progression, particularly in individuals with more advanced disease or inadequate treatment.[9,10] Studies have demonstrated that oral lesions can occur in up to 50% of HIV-infected individuals, and up to 80% of individuals with AIDS.[10,11] While the incidence of oral complications varies widely (with estimates reported between 30 and90%),[8,12,13] these issues continue to play a significant role in the health challenges faced by individuals with HIV across different stages of disease and treatment. HIV-related oral health problems can also alter the oral microbiota and natural immune defense, increasing the risk of periodontal diseases, which are linked with systemic inflammation and an elevated risk of cardiovascular disease. This inflammation cascade further compromises systemic health by allowing for opportunistic infections.[10,14,15]

With the introduction of more advanced ART and earlier HIV diagnosis, the prognosis for

individuals living with HIV has significantly improved. ART reduces viral loads, facilitates partial recovery of the immune system, and prevents opportunistic infections. This has resulted in decreased oral health complications, such as candidiasis, oral manifestations of Kaposi's sarcoma, and hairy leukoplakia, and can now be used as a marker of successful ART regimens.[16] On the other hand, ART can also result in reduced saliva, increasing the risk of xerostomia (dry mouth), and oral dysbiosis.[17] A disrupted microbiome environment leaves the mouth vulnerable to colonization by nonideal and sometimes multi-resistant microorganisms, such as those causing oral candidiasis.[17] These side effects can increase the risk of more serious oral health complications, such as periodontal disease and dental caries.[18] With increasing uptake of ART among individuals with HIV, it is necessary to recognize its potential oral side effects, such as xerostomia and oral dysbiosis. Proactive dental care may help mitigate these impacts, reducing the risk of serious complications like periodontal disease and dental caries, and supporting overall long-term health management for individuals on ART.

Individuals from socioeconomically disadvantaged groups with HIV often have poorer disease prognoses and higher rates of uninsured, with increased obstacles in accessing health and oral care.[4] The HIV Cost and Services Utilization Study, the first nationally representative study of patients seeking care for HIV, found that over 14% of HIV positive patients had unmet dental needs, which was more than twice as much as those with unmet medical needs.[19] Low income, lack of insurance, and insufficient Medicaid dental coverage were key contributing factors.[20] In a prospective observational study in North Carolina, HIV-infected non-Hispanic black Americans were 1.6 times more likely than white Americans to experience unmet dental care needs, with issues such as loose teeth, need for extractions, and reliance on episodic, rather than stable, dental care.[21] These findings underscore the additional importance of addressing oral health integration in providing equitable HIV care.

Despite the high prevalence of oral health issues among the HIV patient population and the association between HIV and oral health concerns, as well as the concern for the socioeconomically vulnerable patient population that faces hurdles in terms of equitable care, the impact of dental care on treatment outcomes in this population is unclear. The Centers for Medicare and Medicaid Services partnered with the Agency for Healthcare Research and Quality to identify dental services inextricably linked and substantially related to the clinical success of Medicare-covered medical services for people with HIV. This rapid response summarizes the evidence from current literature on the impact of dental services and oral health management for patients with HIV. This review was guided by two Key Questions (KQ) outlined below:

Key Question 1: What is the effectiveness of dental services in improving health outcomes in people with HIV before, during, or after HIV treatment?

Key Question 2: What are the clinical practice guidelines or standards for dental care for people with HIV?

2. Methods

Guided by established best practices for rapid evidence reviews,[22] the process of this rapid review included the following phases:

- Literature search
- Study screening and selection
- Data extraction of primary studies and systematic reviews (SRs)
- Risk of bias (RoB) assessment of individual studies and SRs
- Data synthesis, i.e., evidence mapping to Key Questions and qualitative synthesis

2.1 Literature Search

We conducted literature searches across the following biomedical databases for peer-reviewed randomized controlled trials (RCTs), observational studies, SRs, and clinical practice guidelines: Ovid Medline®, Embase®, APA PsycINFO®, and Ovid Emcare. An experienced librarian conducted these searches, using a combination of medical subject headings (i.e., controlled vocabularies) and keywords, adapted to each database's syntax. The search strategies included terms for both the intervention and condition, along with Boolean operators. Results were limited to English language studies on human participants and covered publications from the last 20 years (from 2004 to present).

Appendix A includes a detailed search strategy. SRs were also reviewed, and their citations cross-referenced to ensure that no relevant articles were missed in the initial searches.

To address KQ2, we conducted a manual search for clinical practice guidelines or standards of dental care in the following professional organization websites: Centers for Disease Prevention and Control, Health Resources and Services Administration, World Health Organization, National Institute for Health and Care Excellence, American Dental Association, American Academy of Oral Medicine, American College of Physicians, International AIDS Society, AIDS Healthcare Foundation, and Infectious Diseases Society of America. Additionally, we consulted our clinical SMEs for relevant clinical practice guidelines.

2.2 Study Screening and Selection

We based our study selection on the predefined Population, Intervention, Comparator, Outcome(s), Timing, and Setting (PICOTS) inclusion and exclusion criteria in **Table 1**. We used Covidence[23] to manage the screening of the articles. We selected studies in a two-step process. First, two team members independently reviewed all the titles and abstracts identified from the literature database searches. Team members resolved conflicts through discussion and consensus. The second step was the retrieval of full texts of relevant or potentially relevant abstracts. Two team members independently reviewed all full publications and resolved conflicts through discussion. Exclusion reasons were documented at the full-text level. Clinical subject matter experts (SMEs) reviewed the list of eligible inclusions to ensure that no influential or landmark publications within the clinical community were missed and to identify publications that lacked clinical applicability for exclusion.

Table 1. Study eligibility (PICOTS) criteria

Category	Inclusion Criteria	Exclusion Criteria
Population	Adults ≥18 years with HIV receiving or planning to receive treatment for HIV	People 0-17 years of age People with oral cancer
Intervention	Dental services initiated before, during or after HIV treatment: ● Routine professional preventative dental services (exam/cleaning) ● Any dental treatment including but not limited to periodontitis treatment, tooth extraction, root canal, dental implant	● Interventions other than professional dental services ● Home oral hygiene practices
Comparator	No comparator group was required.	-
Outcome(s)	● Primary and opportunistic infections (bacterial, viral, fungal) ● Systemic inflammatory complications ● Adverse effects of pharmacologic treatments: dry mouth, periodontal disease, fungal infections ● Disease severity (CD4 cell count, viral load)	● HIV disease related outcomes ● Dental health and dental procedure outcomes ● Numeric data not available
Timing	Follow-up time: any duration post-dental treatment	-
Setting	● Inpatient and outpatient settings in the United States (or its territory, embassy, or military installation), including HIV Special Projects of National Significance Program ● Other countries may be included if insufficient studies (less than 10 studies and/or systematic reviews) are available from the US alone.	-
Study Design	● Systematic reviews with or without meta-analyses ● Randomized controlled trials ● Comparative or non-comparative, prospective or retrospective observational studies, including cohorts, case-controls, population studies ● Clinical practice guidelines	● Narrative reviews ● Laboratory studies ● Animal studies ● Non-clinical publications ● Conference abstracts
Language	English language publications	Non-English language publications
Publication dates	● Primary studies: 2004 – 2024 ● Systematic reviews: 2004 – 2024 ● Clinical practice guidelines: 2004 – 2024	Publications outside of the defined date range

2.3 Data Extraction

One reviewer extracted data from the included studies, and another reviewer verified the accuracy of the data.

For each included primary study, we extracted the following information:

- General study characteristics: author, year of publication, country, funding source
- Study design: study design, study population eligibility criteria, sample size, follow-up duration, setting
- Study population characteristics: age, gender/sex, race/ethnicity, smoking, AIDS, comorbidities, treatment for HIV
- Intervention: dental services including routine professional dental care (exam/cleaning), any dental treatment, any patient education on oral health by a dentist or dental professional, timing of dental services relative to the timing of treatment for HIV

- Outcomes of interest: listed in **Table 1**

For each included SR, we extracted the following information:

- Date ranges of the literature search
- Number and study design of included primary studies
- The primary conclusions
- Any strength of evidence assessment that was performed
- Outcomes of interest: listed in **Table 1**

2.4 Risk of Bias Assessments

We assessed the methodological quality of the included primary studies using the Cochrane Risk of Bias (RoB2)[24] for RCTs, Cochrane ROBINS-I[25] for non-randomized controlled interventional studies, and the Newcastle-Ottawa scale[26] for cohort and case-control studies. We assessed SRs using AMSTAR2.[27] RoB2 determined RCTs to have low risk of bias, some concerns, or high risk of bias. ROBINS-I gave non-randomized controlled interventional studies a score of low, moderate, serious, or critical risk of bias. AMSTAR2 classified systematic reviews as high, moderate, low, or critically low confidence. To facilitate better comprehension, we mapped the quality of evidence across the three different tools to the United States Preventive Services Task Force (USPSTF)[28] 3-point scale of good, fair, and poor quality, as shown in **Table 2** below.

Table 2. Mapping quality terms from risk of bias assessments of included studies

USPSTF Quality Term Used in This Report	AMSTAR2 Rating	ROBINS Rating	RoB2 Rating
Good	High confidence	Low risk of bias	Low risk of bias
Fair	Moderate confidence	Moderate risk of bias	Some concerns
Poor	Low confidence	Serious risk of bias	High risk of bias
	Critically low confidence	Critical risk of bias	n/a

2.5 Data Synthesis

We developed a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[29] flow diagram to illustrate the number of studies involved in the literature search and each step of the study selection process. We compiled data into evidence tables and synthesized them narratively and visually. In addition to qualitative synthesis, we organized summary tables by Key Questions and by outcome of interest when appropriate. We highlighted any gaps in evidence, with attention given to direct comparisons between the receipt of dental care and HIV-related outcomes. The subgroup analysis was narrative and was done to assess outcomes reported in at least three studies. We consulted our clinical SMEs to answer KQ2 by using select references from the literature and/or from clinical practice guidelines. In our report, we provided key information and data from these references. The clinical SMEs critically reviewed the final report to ensure accurate clinical contextualization of any findings.

3. Results

3.1 Literature Search Findings

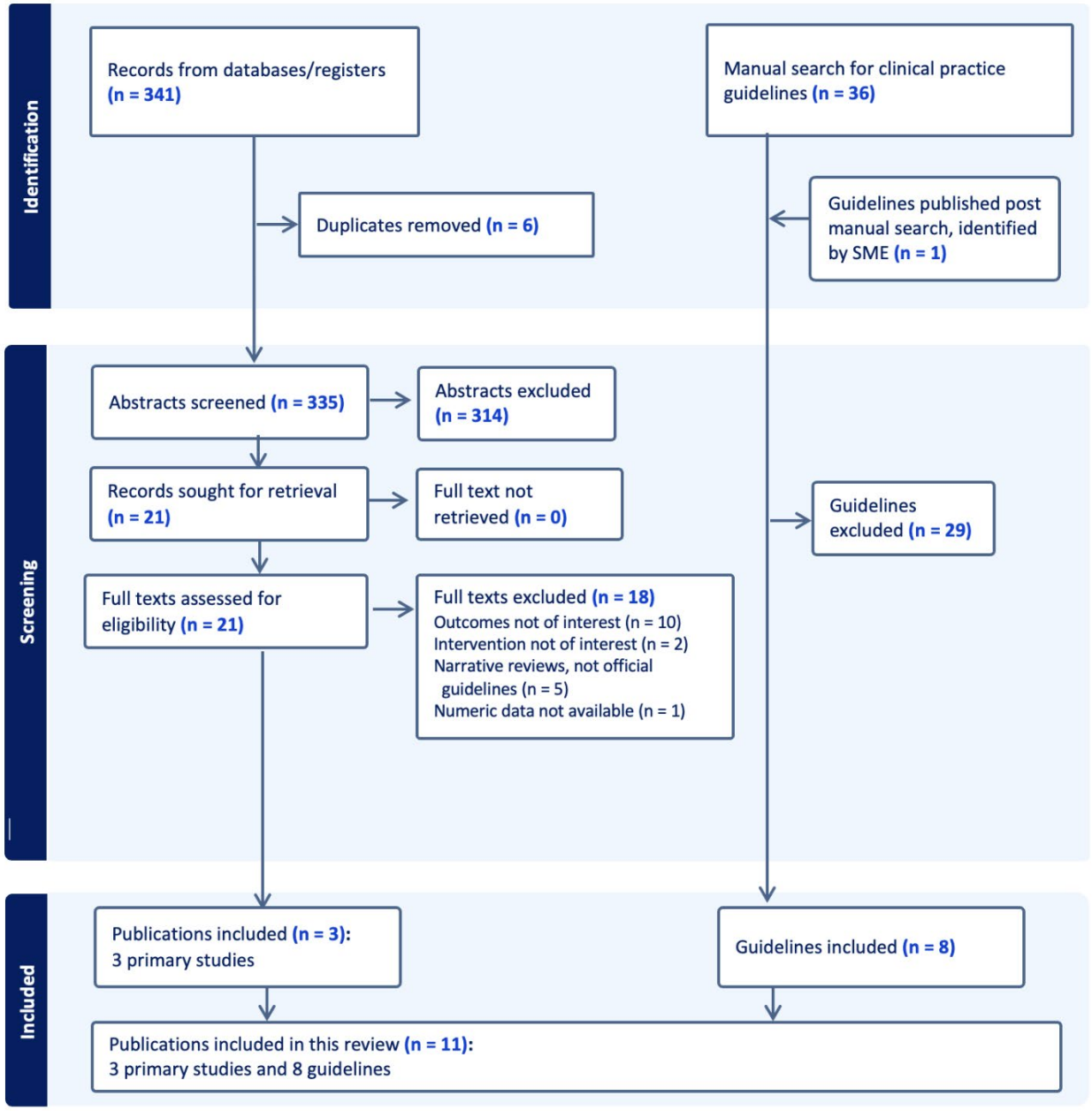
Figure 1 depicts the PRISMA flow diagram summarizing the literature search results. An electronic database search conducted on October 22, 2024, in Ovid Medline®, Embase®, APA PsycINFO®, and Ovid Emcare yielded 341 citations. After six duplicates were removed, the titles and abstracts of all 335 citations were screened for eligibility, of which 314 were excluded. Out of 21 full-text articles reviewed for eligibility, 18 were excluded. Thus, the electronic database search produced three unique publications for this rapid response review. Appendix B provides a list of references excluded at the full-text level and their reasons for exclusion.

Our manual searches for clinical practice guidelines identified 36 guidelines for people with HIV, of which seven included dental care management recommendations. Following our manual search, our technical experts identified an additional guideline published post-manual search, bringing our total guidelines to eight. Appendix C provides a list of 29 overall health management guidelines that did not contain information on dental care.

Therefore, this rapid response review included data from eleven publications, including three primary studies addressing KQ1 and eight guideline articles addressing KQ2.

3.1 Results, Literature Search Findings

Figure 1. PRISMA flow diagram



3.2 Key Question 1

Key Question 1: What is the effectiveness of dental services in improving health outcomes in people with HIV before, during, or after HIV treatment?

3.2.1 Key Points

- The body of evidence informing KQ1 consists of three poor-quality single-arm studies evaluating the impact of non-surgical periodontal treatment (NSPT) in HIV-positive patients with periodontitis.
- All three non-comparative studies were small (sample size: 15 to 63), with follow-up duration ranging from three to 24 months.
- Weak evidence from all three single-arm studies found statistically significant increase in CD4 count after NSPT.
- Weak evidence from two single-arm studies reported no significant change in viral load after NSPT.
- Evidence on other HIV-related outcomes or adverse events associated with NSPT during ART is unavailable.
- There was no evidence for other dental services, such as preventive dental care and oral surgery, and their effect before or after ART initiation. Details on ART regimen were unavailable in these studies, leading to the inability to assess potential interactions between dental treatment and ART type or regimen.
- Overall, the body of evidence for KQ1 was limited by the lack of direct comparative data, and the risk of selection and attrition bias due to small and specific study populations, and high dropout rates, respectively.

3.2.2 Included Studies

Our literature database search identified three primary studies that assessed the effect of dental services on health outcomes among patients with HIV. No relevant SR was found.

3.2.2.1 Study Design and Population Characteristics

Table 3 provides an overview of the study design and population characteristics of the three included primary studies. None of the studies compared dental treatment with no dental care and, therefore, were considered single-arm (non-comparative) studies for this review. One study was conducted in the US,[30] and two were in Brazil.[31,32] Sample sizes were small. The two Brazilian studies included less than 25 patients each, and followed these patients for 3-6 months.[31,32] The US study enrolled 63 HIV-positive patients on antiretroviral therapy and followed up for 24 months, with an attrition rate of over 38% (24/63 loss-to-follow-up).[30] All three studies enrolled more men than women (66.6% to 74.0% male), and the average age in these studies was similar (43.9 to 45.7 years old). Nobre et al. enrolled only patients with CD4 <200 cells/mm^3 and on ART, meaning that the entire study population had AIDS.[31] In one Brazilian study, Nobre et al., patients were on ART,[31] and in another Brazilian study, Noro Filho et al., patients had been on highly active antiretroviral therapy (HAART) for at least three years.[32] The US study, Valentine et al., included 12 patients who were on ART for <12 months and 51 patients who had been on ART for >12 months. [30] The type of ART medication used was unavailable in all three studies. All three studies assess CD4 count and viral load.

All three studies enrolled HIV-positive patients who had periodontitis.[30–32] Periodontitis diagnosis and staging were performed according to the Armitage 1999 definition in the two Brazilian studies,[31,32] and the American Academy of Periodontology/Centers for Disease Control and Prevention definition in the US study.[30] All three studies treated patients with non-surgical

3.2.2 Results, Key Question 1, Included Studies

periodontal treatment (NSPT) that included scaling and root planning (SRP) and oral hygiene instructions (OHI). Details of these dental treatments are available in **Table 3**.

Since the included studies are single-arm studies, we used the Newcastle Ottawa Scale to assess their risk of bias, as shown in Appendix D. We rated all three studies as poor quality (having high risk of bias), due to small sample size, high dropout rate, and the lack of comparison group.

Table 3. Study design and population characteristics of the included primary studies

Author Year Country Funding	Study Design Sample Size Followup Length Periodontitis Definition	Study Inclusion Criteria	Mean Age Male % AIDS % Duration of HIV Seropositivity Other	Dental Treatment	Outcomes Assessed
Nobre[31] **2019** **Brazil** **Federal funding** **High RoB/poor quality**	Single-arm study[a] 22 pts on ART 90 d Periodontitis: Armitage 1999 definition	Had HIV for ≥1 year, CD4 count <200 cells/mm^3, aged ≥18 yr, with chronic periodontitis, with ≥12 natural teeth, no periodontal therapy or antibiotic treatment the last 6 mo, no systemic diseases	44.8 yr 63.6% 100% 13.5 yr 68.2% white 2.4% alcohol user	NSPT: supragingival biofilm control and subgingival SRP OHI: weekly meetings for instructions on oral health and biofilm control	CD4 count Viral load IL-6 [b] IL-8 [b] TNF-α[b]
Noro Filho[32] **2013** **Brazil** **Federal funding** **High RoB/poor quality**	Single-arm study 15 on HAART for 3 years 6 mo Periodontitis: Armitage 1999 definition	HIV+, with periodontitis, had HAART for more than 3 yrs with no change of dose or medication protocols, no systemic diseases	45.7 yr 66.6% NR NR 73.3% white 73.3% homosexual 33.3% smokers	NSPT with ultrasonic scaler; then supragingival prophylaxis and OHI weekly during the 1st month then monthly until the 6th month	CD4 count Viral load

3.2.2 Results, Key Question 1, Included Studies

Author Year Country Funding	Study Design Sample Size Followup Length Periodontitis Definition	Study Inclusion Criteria	Mean Age Male % AIDS % Duration of HIV Seropositivity Other	Dental Treatment	Outcomes Assessed
Valentine 2016[30] **US** **Federal funding** **High RoB/poor quality**	Single-arm study 63 of which 39 completed 24 mo follow-up [c] 12 on ART for <12 mo 51 on ART for >12 mo 24 mo Periodontitis: AAP/CDC definition	Aged ≥18 yr, HIV+, no dental care for ≥12 mo	43.9 yr 74.0% NR NR 32.9% white 45.21% smokers 51% moderate periodontitis	Comprehensive dental care included dental prophylaxis every 6 mo, SRP, OHI, extractions, restorative and prosthetic dental treatment	CD4 count Viral load [d] IL-6[d]

Abbreviations: AAP = American Academy of Periodontology; AIDS = acquired immune deficiency syndrome; CDC = Centers for Disease Control and Prevention; d = days; HAART = highly active antiretroviral therapy; HIV = human immunodeficiency; IL = interleukin; mo = months; NSPT = nonsurgical periodontal treatment; NR = not reported; OHI = oral hygiene instruction; SRP = scaling and root planning; yr = years.

[a]Nobre et al. enrolled both HIV and non-HIV participants. For this rapid response review, we included data from the 22 HIV positive patients only.

[b]Nobre et al. reported IL-6, IL-8, and TNF-α but only in figures; numeric data were not available.

[c]Valentine et al. enrolled HIV+ patients both with and without antiretroviral therapy. For this rapid response review, we included data from 63 patients on antiretroviral therapy.

[d]Valentine et al. reported IL-6, and viral load but only in figures; numeric data were not available.

3.2.2.2 Reported Outcomes

Table 4 summarizes the findings of the included primary studies. All three studies reported statistically significant increased CD4 count from baseline. Nobre et al. reported a statistically significant trend of improved CD4 count from baseline to 90 days (p=0.012).[31] Similarly, NoroFilho et al. found statistically significant increased CD4 count from baseline to three months (p=0.01) and from baseline to six months (p<0.000).[32] In the US study, Valentine et al. provided subgroup analysis by three groups: short term ART (those treated with ART for <1 year), long term ART, not suppressed (those treated with ART for >1 year and with detectable HIV viral load), and long term ART, suppressed (those treated with ART for >1 year and with undetectable HIV viral load).[30] Valentine et al. found statistically significant increases in CD4 count in all 3 subgroups (p = 0.007 to p = 0.01).

In addition to CD4 count, the two Brazilian studies reported change in viral load, and found no statistically significant change.[31,32]

3.2.2 Results, Key Question 1, Included Studies

Table 4. Summary of findings in the included primary studies

Author Year Country	Study Design Total Sample Size	Outcome	Timing; Subgroup (Sample Size)	Results	P Value
Nobre[b] 2019[31] Brazil	Single-arm study[a] 22	CD4 count (cells/mm^3) (mean ± SD)	Baseline (n=22)	104.7 ± 57.3	0.012; Friedman test for trends
	Single-arm study[a] 22	CD4 count (cells/mm^3) (mean ± SD)	30 days (n=22)	165.7 ± 110.4	0.012; Friedman test for trends
	Single-arm study[a] 22	CD4 count (cells/mm^3) (mean ± SD)	90 days (n=22)	195.6 ± 155.2	0.012; Friedman test for trends
	Single-arm study[a] 22	Viral load (copies/ml) (mean ± SD)	Baseline (n=22)	1,444,892.2 ± 423,174.5	0.2984; Friedman test for trends
	Single-arm study[a] 22	Viral load (copies/ml) (mean ± SD)	30 days (n=22)	19,547.4 ± 66,181.4	0.2984; Friedman test for trends
	Single-arm study[a] 22	Viral load (copies/ml) (mean ± SD)	90 days (n=22)	28,380.8 ± 103,229.3	0.2984; Friedman test for trends
Noro Filho 2013[32] Brazil	Single-arm study 15	CD4 count (cells/mm^3) (mean ± SD)	Baseline (n=15)	548.3 ± 193.4	-
	Single-arm study 15	CD4 count (cells/mm^3) (mean ± SD)	3 mo (n=15)	709.7 ± 310.1	0.01 (baseline-3 mo)
	Single-arm study 15	CD4 count (cells/mm^3) (mean ± SD)	6 mo (n=15)	759.3 ± 302.6	0.00 (baseline-6 mo)
	Single-arm study 15	Viral load (copies/ml) (mean ± SD)	Baseline (n=15)	2383.9 ± 6328.6	-
	Single-arm study 15	Viral load (copies/ml) (mean ± SD)	3 mo (n=15)	1266.2 ± 4904.4	0.59 (baseline-3 mo)
	Single-arm study 15	Viral load (copies/ml) (mean ± SD)	6 mo (n=15)	0.0 ± 0.0 (none of the patients had detectable viral load)	0.17 (baseline – 6 mo)

3.2.2 Results, Key Question 1, Included Studies

Author Year Country	Study Design Total Sample Size	Outcome	Timing; Subgroup (Sample Size)	Results	P Value
Valentine[d] 2016[30] US	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	Baseline; short-term ART (n=12)	468	0.007
	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	24 mo; short-term ART (n=8)	655	0.007
	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	Baseline; long-term ART (n=23)	437	0.01
	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	24 mo; long-term ART (n=6)	783	0.01
	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	Baseline; long-term ART-suppressed (n=28)	469	0.01
	Single-arm study 63 (at baseline); 39 (at 24 mo) [c]	CD4 count (cells/mm^3) (median)	24 mo; long-term ART-suppressed (n=25)	647	0.01

Abbreviations: ART = antiretroviral therapy; mo = months; SD = standard deviation.

[a]Nobre et al. enrolled both HIV and non-HIV participants. For this rapid response review, we included data from the 22 HIV positive patients only.
[b]Nobre et al. also reported IL-6, IL-8, and TNF-α but only in figures; numeric data were not available.
[c]Valentine et al. enrolled HIV+ patients both with and without antiretroviral therapy. For this rapid response review, we included data from 63 patients on antiretroviral therapy.
[d]Valentine et al. also reported IL-6, and viral load but only in figures; numeric data were not available.

3.3 Key Question 2

Key Question 2: What are the clinical practice guidelines or standards for dental care for people with HIV?

3.3.1 Key Points

- Our search identified eight publications with dental care recommendations for patients with HIV. These include seven guidance articles from US-based professional organizations or government agencies and one narrative review with dental care recommendations from a group of oral health experts in India.
- The guidelines consistently emphasize the importance of preventive oral care and include specific strategies to manage common HIV-related oral disease concerns, including xerostomia, acid reflux, and increased susceptibility to decay and periodontal disease.
- The guidelines consider standard dental care practices and necessary invasive dental treatments safe for patients with HIV, and recommend against antibiotic prophylaxis in well controlled cases, except when deemed medically necessary on a case-by-case basis.
- Guidelines encourage collaboration between primary care providers and dental providers to optimize the management of oral health for patients with HIV.

3.3.2 Included Guidelines

Our literature search for clinical practice guidelines identified eight guidelines with dental care management recommendations for people with HIV and AIDS. **Table 5** summarizes the details of these eight guidelines and recommendations.[33-39]

Seven guidelines were published by US-based professional organizations and advisory or working groups,[33–39] and one review with recommendations by dental health experts in India.[40] Four in particular are informed by published literature,[33,34,37,39] and one is used as part of a training series for health care providers.[38] Three target the oral health profession and the remaining five[34,36–39] address a broader audience of healthcare providers, and all guidelines emphasize the integration of oral health into the overall care for individuals with HIV. The guidelines generally use inclusive language, referring to people with HIV or HIV-positive individuals rather than categorizing individuals as having AIDS.

All eight sources emphasize that dental care for HIV-positive patients generally follow standard practices for healthy patients, with treatment modifications recommended based on specific health conditions or severely compromised cases of HIV. For example, a recently updated guideline from the HIV Medicine Association of the Infectious Diseases Society of America emphasizes patient-centered care, integrating routine and preventive dental health into HIV management,[34] and as described in the Saveetha Dental College guidelines, standard dental care applies to patients on ART with well-controlled HIV.[33] However, for those with advanced or uncontrolled stages, more specialized treatment plans may be necessary. Guidelines from the Pacific AIDS Education and Training Center and the U.S. Department of Health and Human Services similarly recommend modifications for complex cases, such as identified bleeding risks, severely immune compromised, or severe disease symptoms.[35,37]

Preventive strategies are highlighted across all eight sources, reflecting a shared focus on managing common HIV-related oral health concerns, including xerostomia, acid reflux, and increased susceptibility to decay and periodontal disease. For instance, the guidelines published by the Southeast AIDS Education & Training Center address preventive measures like fluoride use, oral hygiene advice, and caries management strategies tailored to higher-risk HIV-positive patients.[36] The recommendations stress the need for comprehensive initial and routine assessments, with all sources advocating thorough medical histories, oral exams, and tracking of CD4 counts and viral loads to monitor immune status.

3.3.2 Results, Key Question 2, Included Guidelines

These published dental care recommendations consistently state that invasive dental procedures, such as surgery and implants, are generally safe for HIV patients. However, five of the eight guidelines,[33,35–37,40] recommend pre-treatment lab checks for patients with advanced HIV to monitor for any abnormalities that could necessitate treatment adjustments. In particular, the Saveetha Dental College's guidelines distinctly tailors oral care to ART adherence and HIV progression stages, incorporating comprehensive hematological exams before and after dental procedures in order to reduce the risk of infection in these immunocompromised individuals.[40] All reviewed guidelines indicate that lab values, such as CD4 counts and viral loads, should not automatically be grounds for withholding dental treatment. Instead, these values may inform decisions on any necessary adjustments for invasive procedures. The Pacific AIDS Education and Training Center guidelines, for instance, stresses that dental treatment should proceed as usual unless the patient's medical status necessitates modifications.[35] Practice guidelines from San Diego county take it a degree further in recommending not only hematological checks, but also pre-treatment antibacterial mouth rinses, periodontal exams, and recall schedules for all HIV patients.[33]

Four of the eight[33,35,36,40] guidelines advise against routine antibiotic prophylaxis for well-controlled HIV patients. The guidelines suggest that prophylaxis should be reserved for specific cases where a patient has a severely compromised immune system or other risk factors that make additional precautions necessary. The Pacific AIDS Education & Training Center's Oral Health Advisory Group further provides a list of potential interactions with antiretrovirals in the case of medically necessary antibiotic prophylaxis use.[34]

Guidelines also focus on the importance of primary care providers in managing oral healthcare for HIV patients. For instance, the Center for Oral Health discusses the role of primary care physicians in identifying oral manifestations, such as dry mouth, salivary gland disease, gingivitis, and ulcers, and integrating oral exams into routine health assessments.[39] The guidelines from the U.S. Department of Health and Human Services also stresses the need for collaboration between primary care physicians and dentists to improve the management of oral health complications associated with HIV and/or antiretroviral or other treatment, and specifically encourages oral cavity exams in routine physicals, outlining how primary care physicians should refer patients to oral health professionals if signs of HIV-related oral conditions are detected.[37] The HIV Medicine Association of the Infectious Diseases Society of America guidelines recommend shared decision-making for surgical and dental decisions involving individuals with HIV, incorporating input from the HIV provider, surgeon, and patient.[34]

Six guidelines list the types of oral health issues that may require monitoring due to oral sequelae of HIV or adverse effects of ART, such as xerostomia, periodontal disease, and oral HPV. The Southeast AIDS Education & Training Center's resource guide details how consistent ART use has reduced the prevalence of certain conditions, such as oral candidiasis and Kaposi's sarcoma, but emphasizes ongoing monitoring and hygiene vigilance.[36] The guidelines from San Diego County also outline measures to help detect and manage oral conditions, including regular follow-ups.[33]

In four guidelines,[33,35,39,40] nutritional counseling and education on lifestyle risks is recommended as part of a comprehensive approach to managing HIV-related oral health. For example, the Saveetha Dental College guidelines emphasize counseling on oral hygiene, lifestyle risks, and nutritional advice to address the heightened risk for oral diseases in HIV patients.[40] The San Diego County guidelines similarly note the role of dentists in providing oral health

education on caries prevention, smoking cessation, and identifying oral issues that then may benefit from lifestyle counseling.[33]

Table 5. Clinical practice guidelines or standards of oral health and dental care management for patients with HIV and AIDS

Professional organization or source	Title (year)	Type of publication; target audience	Summary of recommendations
HIV Medicine Association of the Infectious Diseases Society of America[34]	Primary Care Guidance for Providers Who Care for People With Human Immunodeficiency Virus: 2024 Update by the HIV Medicine Association of the Infectious Diseases Society of America (2024)	Guidelines; healthcare providers	The 2024 update to the *Primary Care Guidance for Providers Who Care for Persons With Human Immunodeficiency Virus*, and led by an expert panel, addresses the evolving needs of HIV care and emphasizes patient-centered approaches to optimize outcomes. This update highlights the importance of integrating dental care into routine healthcare maintenance and preventative health screenings, and prioritizing specific oral health concerns: gum disease, ulcers, oral lesions, and pain. It further underscores that surgical and dental decisions for individuals with HIV should be guided by shared decision-making among the HIV primary healthcare provider, surgeon, and patient. These decisions should carefully weigh all relevant factors and not be based solely on CD4 cell counts or HIV RNA levels.
Los Angeles County Commission on HIV Health Services + San Diego County Standards of Care Dental Working Group[33]	Practice Guidelines for the Treatment of HIV Patients in General Dentistry, County of San Diego (2011)	Guidelines; dentists	These clinical practice guidelines for the County of San Diego, adapted from original content from Los Angeles County Commission on HIV Health Services, focus on HIV patient care in general dentistry. Emphasis is placed on dentists' key role in monitoring immune status and ensuring patients' adherence to HIV medications. Antibiotic prophylaxis is not recommended for well-controlled HIV patients, but annual health history updates, extra-oral exams, and coordination with primary care physicians are considered vital. While no changes in dental treatment are needed solely based on HIV status, adjustments may be required for severally medically compromised patients. Key recommendations for all HIV patients include pre-treatment antibacterial mouth rinses, regular periodontal exams, and six-month recall schedules, or in the case of severely immunosuppressed patients with CD4 counts above 100, three months. Dentists should also monitor ART medication side effects like xerostomia, provide oral health education on caries prevention and smoking cessation, and identify oral manifestations that may require nutritional or lifestyle counseling.
Pacific AIDS Education & Training Center's Oral Health Advisory Group[35]	Practice Guidelines for the Treatment of HIV Patients in General Dentistry (updated 2015)	Guidelines; dentists	These clinical practice guidelines, published by Oral Health Advisory Group of the Pacific AIDS Education and Training Center and requested by the Los Angeles Commission on HIV, focus on HIV patient care in general dentistry. It emphasizes the importance of comprehensive medical and oral health assessments, including intake and periodic updates of patient's health status, CD4 and viral load counts, and medication lists. They advise against routine antibiotic prophylaxis with oral health care unless deemed medically necessary and have also provided al list of potential interactions to consider with ARVs. Oral health care should be routine, however if medical status is complex or further compromised, and bleeding tendencies are higher, treatment can be modified, and use of local anesthetics and anticoagulants should be considered. It also highlights the need for regular follow-ups, good oral hygiene, and nutritional counseling.

3.3.2 Results, Key Question 2, Included Guidelines

Professional organization or source	Title (year)	Type of publication; target audience	Summary of recommendations
Southeast AIDS Education & Training Center Program (SE AETC)[36]	Oral Health Medical/Dental Considerations for Patients with HIV on Antiretroviral Therapy (2018)	Guide; healthcare providers	This quick resource guide, published by the Southeast AIDS Education & Training Center Program, focus on oral health of HIV patients across medical professions, and emphasizes the importance of consistent ART in reducing oral manifestations of HIV. It outlines key medical and dental considerations, including when to communicate with other health professionals. Specific oral issues associated with ART, such as xerostomia, dental decay, periodontal disease, and oral HPV, are noted, along with recommendations for oral and medical treatments. The guide also highlights conditions that are decreasing with ART, such as candidiasis, necrotizing gingivitis, Kaposi's sarcoma, and oral hairy leukoplakia. It includes guidance on important lab values and when to consult medical professionals, with antibiotic prophylaxis recommended only in specific cases.
U.S. Department of Health and Human Services, Health Resources and Services Administration, HIV/AIDS Bureau[37]	Guide for HIV/AIDS Clinical Care (2014, updated 2024)	Guide; healthcare providers	This guide outlines best practices for primary care physicians in the clinical management of HIV and AIDS, with a focus on integrating oral health into overall care. It emphasizes including oral cavity exams as part of routine physical exams, with referrals to oral health professionals for suspected oral manifestations. Examples of oral health conditions—such as ulceration, warts, hairy leukoplakia, necrotizing ulcerative periodontitis, and gingivitis—are provided to support nuanced assessments, diagnoses, and treatment planning, as well as considerations in the case of ART or ART-naïve patients. The guide also addresses oral health services performance measures, covering key areas like dental and medical history, treatment plans, oral health education, periodontal screenings or exams, and phase 1 treatment completion.
Health Resources and Services Administration (HRSA) Special Projects of National Significance (SPNS) Innovations in Oral Health Care Initiative (Oral Health Initiative)[38]	Intervention Guide— SPNS Demonstration Model of Oral Health Care (2018)	Guide; healthcare providers	The SPNS Oral Health Care Intervention Guide provides recommendations on integrating oral health within HIV care, covering areas like establishing cross-disciplinary collaboration between HIV and dental care teams, creating referral processes, and tailoring services to meet patient needs. It also suggests trauma-informed approaches, strategies for outreach and engagement, methods for staff training, and ways to address barriers to care, with the aim to improve both access and retention for HIV-positive individuals.
Center for Oral Health (COH)[39]	Primary Care Recommendations for Oral Health Care in HIV+ Patients (2014)	Recommendations; healthcare providers	These recommendations, published by the Center for Oral Health, focus on defining how primary care physicians can play a key role in advocating for oral health care in patients with HIV/AIDS, especially in cases where patients lack access to regular dental care. Physicians are advised to identify common oral health manifestations of HIV, such as dry mouth, salivary gland disease, gingivitis, periodontitis, infections, ulcers, and oral cancers. Oral exams should be part of routine physicals, along with assessments of oral health hygiene and lifestyle factors that impact oral health. Treatment plans should include dental hygiene advice. The recommendations also emphasize the need for increased oral health training for primary care physicians treating patients with HIV and collaboration between physicians and dentists to reduce oral complications and improve HIV management.

3.3.2 Results, Key Question 2, Included Guidelines

Professional organization or source	Title (year)	Type of publication; target audience	Summary of recommendations
Divyadarshini V et al. Saveetha Dental College[40]	Clinical Practice Guidelines for Oral Health Management in HIV Patients (2022)	Narrative review; dentists	These clinical practice guidelines, published by oral health providers at Saveetha Dental College and Hospitals in India, focus on integrating oral care into the overall care of HIV-positive patients. They recommend adhering to routine and conventional dental care standards for patients on ART with controlled infection, while emphasizing the need for specialized treatment plans in advanced and uncontrolled stages of the disease. Key considerations include completing comprehensive initial extraoral and intraoral assessments and medical history reviews, and continued monitoring for oral lesions and manifestations of HIV, and providing education on lifestyle risks, nutrition, and oral hygiene. Prevention is stressed, given the heightened susceptibility to oral diseases with HIV, and antibiotics should only be prescribed when necessary. Hematological investigations are recommended prior to dental treatments to account for immunocompromised states and ART side effects, with guidance provided for before and after invasive procedures to minimize infection risk.

Abbreviations: AIDS = acquired immune deficiency syndrome; ART = antiretroviral therapy; HIV = human immunodeficiency virus

4. Discussion

4.1 Overview

The objective of this rapid response was twofold: (i) to identify and synthesize the existing evidence on the effectiveness of dental services in improving health outcomes in patients with HIV before, during, or after HIV treatment, and (ii) to review the standard of dental care practices for this patient population. Our literature review identified three primary studies and eight relevant guidelines.

Patients with HIV often present with various oral and dental diseases, including dental caries, xerostomia, gingivitis, periodontitis, canker sores, oral warts, fever blisters, thrush (oral candidiasis), hairy leukoplakia, and dental caries.[7,10,41] Patients with HIV had a statistically significantly higher prevalence of dental caries compared with those without HIV infection.[42] The National Institute of Dental and Craniofacial Research attributed this increased risk to the weakened immune system.[7]

The body of evidence evaluating the effectiveness of dental services on HIV outcomes is limited to three non-comparative (single-arm) studies of patients with HIV and periodontitis. Of these three included studies, two were small, with sample size of less than 25,[31,32] and the third had a high attrition rate (32%).[30] There is potential selection bias due to the small and specific study population, as well as possible attrition bias if those lost-to-follow-up had different outcomes. In all three studies, all patients received NSPT, and consistently found statistically significant increased CD4 count from baseline. Two[30,32] of these three studies observed an increase of at least 100 cells/mm^3 from baseline, indicating a clinically meaningful improvement in immune function and reduced risk of opportunistic infections.[43] In contrast, two studies reported no change in viral load; it is unclear if the lack of statistically significant change was due to the small sample sizes.[31,32] Data on adverse events associated with ART therapy or other HIV treatment outcomes were unavailable.

Despite the statistically and clinically significant improvement in CD4 count among patients who received NSPT, the noncomparative nature of all three included studies did not allow for direct comparisons, making it difficult to evaluate if the observed results are due to NSPT or other confounding factors, such as general health improvement, overall HIV treatment adherence, healthcare access, and socioeconomic status. The lack of comparative evidence precludes us from drawing definitive statements on the effectiveness of NSPT on health outcomes. In addition, we did not find relevant studies that evaluated the effect of other dental services, such as dental implants, root canals, or tooth extractions. Further, while one study enrolled only patients who were on highly active antiretroviral therapy for at least three years with no dosage or protocol change,[32] there was no evaluation of the timing of dental treatment before or after HIV treatment. Also, the included studies did not report detailed ART regimens, so we were unable to assess potential interaction between dental treatment and ART type or regimen.

Despite the limited primary evidence on the effectiveness of dental services on health outcomes among patients with HIV, eight clinical practice guidelines and review with recommendations emphasize the importance of preventive oral care, including regular dental examination every six months and education on daily oral hygiene. All included guidelines are consensus-based and highlight specific strategies to manage common HIV-related oral issues, such as xerostomia, acid reflux, and increased susceptibility to decay and periodontal disease. The standard dental care practices and necessary invasive dental treatments are considered safe

for patients with HIV. Prophylaxis antibiotics are not recommended consistently and are to be reserved for patient with severely compromised immune systems. Education on lifestyle risk and nutritional counseling are recommended as part of a comprehensive approach to oral health management. Guidelines encourage collaboration between primary care providers and dental providers to optimize the management of oral health for patients with HIV.

4.2 Strengths and Limitations

This systematic review has several strengths, including a comprehensive literature search across multiple databases and a rigorous methodology following rapid review best practices. It effectively synthesized findings from diverse sources, providing valuable insights into any evidence for the relationship between dental care and health outcomes in HIV patients. Additionally, the inclusion of clinical practice guidelines enhances its relevance for healthcare providers.

However, significant limitations exist. All included studies were single-arm, non-comparative designs with small sample sizes, limiting causal inference and generalizability. High dropout rates in some studies introduce potential attrition bias, while the narrow focus on CD4 count and viral load excludes broader implications on patient health. The lack of data on dental services other than NSPT and the underrepresentation of diverse populations further constrain the applicability of findings, highlighting the need for more robust, well controlled studies, including randomized trials, to strengthen the evidence base.

5. Conclusions

The body of evidence evaluating the effectiveness of dental services in improving health outcomes in patients receiving HIV treatment is limited to three small, single-arm studies of poor-quality studies. and therefore, do not permit conclusions on this topic. There was no evidence assessing the effects of dental treatments other than NSPT, nor any interaction between dental treatment and HIV treatment. No evidence was available to draw conclusions on adverse events associated with ART or other HIV-related outcomes. Despite the limited primary evidence, clinical practice guidelines consistently emphasize the importance of preventive oral care and included specific strategies to manage common HIV-related oral diseases concerns. Collaboration between primary care physicians and dental providers is encouraged to optimize the management of oral health among patients with HIV.

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Abbreviations and Acronyms

Acronym	Definition
AAP	American Academy of Periodontology
ADA	American Dental Association
AHRQ	Agency for Healthcare Research and Quality
AIDS	Acquired immune deficiency syndrome
ART	Antiretroviral therapy
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CMS	Centers for Medicare and Medicaid Services
d	Days
HAART	Highly active antiretroviral therapy
HIV	Human immunodeficiency virus
HR	Hazard ratio
IL	Interleukin
KQ	Key Question
MA	Meta analysis
mo	Months
NA	Not applicable
NICE	National Institute for Health and Care Excellence
NIDCR	National institute of Dental and Craniofacial Research
NIMH	National Institute of Mental Health
NR	Not reported
NSPT	Non-surgical periodontal therapy
OHI	Oral hygiene instruction
OR	Odds ratio
PICOTS	Population, Intervention, Comparator, Outcome(s), Timing, and Setting
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomized controlled trial
RoB	Risk of bias
RR	Relative risk
SD	Standard deviation
SME	Subject matter expert
SR	Systematic review
SRP	Scaling and root planing
USPSTF	United States Preventive Services Task Force
yr	Years

Appendix A. Literature Search Strategy

Table A-1. Search strategy, conducted on 10/22/2024

Set#	Searched for	# Results
S1	MJEMB.EXACT.EXPLODE("Human immunodeficiency virus infection") OR MJMESH.EXACT.EXPLODE("HIV Infections")	982239
S2	TI,AB,IF,SU(((HIV OR HIV1 OR HIV2 OR HIV-1 OR HIV-2 OR "human immune deficiency virus" OR "human immunodeficiency virus") N/2 (acute OR primary OR associated OR related OR disease$1 OR infection$1 OR syndrome$1)) OR AIDS OR "acquired immune deficiency syndrome" OR "acquired immunodeficiency syndrome" OR "HIV/AIDS" OR "human immune deficiency virus/acquired immune deficiency syndrome" OR "human immunodeficiency virus infection/acquired immunodeficiency syndrome")	1940596
S3	S1 OR S2	2233061
S4	MJEMB.EXACT.EXPLODE("dental examination") OR MJEMB.EXACT.EXPLODE("dental prevention") OR MJEMB.EXACT.EXPLODE("dental procedure") OR MJEMB.EXACT.EXPLODE("dental prosthesis and implant") OR MJEMB.EXACT.EXPLODE("endodontics") OR MJEMB.EXACT("mouth hygiene") OR MJEMB.EXACT.EXPLODE("periodontics") OR MJEMB.EXACT.EXPLODE("preventive dentistry") OR MJEMB.EXACT.EXPLODE("prosthodontics") OR MJEMB.EXACT.EXPLODE("restorative dentistry") OR MJMESH.EXACT.EXPLODE("Dental Health Services") OR MJMESH.EXACT.EXPLODE("Endodontics") OR MJMESH.EXACT.EXPLODE("Mouth Rehabilitation") OR MJMESH.EXACT.EXPLODE("Periodontics") OR MJMESH.EXACT.EXPLODE("Preventive Dentistry") OR MJMESH.EXACT.EXPLODE("Prosthodontics") OR MJMESH.EXACT.EXPLODE("Public Health Dentistry"	458229
S5	TI,AB(((cavit$3 OR caries OR carious OR dental OR dentistry OR "dry mouth" OR edentul* OR endodont* OR gingivitis OR *gingival OR (gum N/2 (disease* OR infection*)) OR periodont* OR periapical OR pulpal OR pulpitis OR (oral N/2 candidiasis) OR root OR stomatitis OR teeth OR thrush OR tooth OR xerostomia) N/3 (curettage OR clean$3 OR debridement OR exam$1 OR examin$6 OR fill$3 OR hygiene OR implant* OR intervention* OR therap* OR treat* OR procedure$1 OR planing OR prevent$5 OR prophylaxis OR prosthes?s OR prosthetic$1 OR prosthodontic$1 OR repair$3 OR restor$5 OR scaling)) OR ((dental OR oral) N/2 (health OR hygiene)))	622975
S6	S4 OR S5	896839
S7	S3 AND S6	18581
S8	S7 NOT (EMB.EXACT.EXPLODE("pediatric dentistry") OR MESH.EXACT.EXPLODE("Dental Care for Children") OR MESH.EXACT.EXPLODE("Pediatric Dentistry") OR TI,AB(adolescent* OR baby OR babies OR child* OR infant* OR juvenile* OR teen*))	16372
S9	S8 NOT (MJEMB.EXACT.EXPLODE("mouth cancer") OR MJMESH.EXACT.EXPLODE("Mouth Neoplasms") OR TI,AB,IF,SU((oral OR mouth) N/2 (cancer* OR carcino* OR metastas?s OR neoplasm* OR malignan* OR tumo$r*)))	15888
S10	S9 AND (TI,AB,SU,DTYPE(case-control OR ((cohort$1 OR co-hort$1) N/2 (analys?s OR comparat$3 OR stud$3 OR trial$1)) OR ((control$5 OR epidemiologic$2 OR evaluat$4 OR exploratory OR interventional OR longitudinal OR observational OR pivotal OR prospective OR random$5 OR registrational OR retrospective) N/5 (analys$s OR evaluation$1 OR review$1 OR stud$3 OR trial$4)) OR (random$5 N/2 control$5) OR (systematic$5 N/1 review$3) OR meta-analys?s OR metanalys?s OR metaanalys?s OR "MACS-WIHS Combined Cohort Study" OR MWCCS OR "Special Projects of National Significance" OR SPNS) OR TI(guideline$1 OR consensus OR position$1 OR recommend$6 OR requirement$1 OR statement$1 OR "task force$1" OR "working group$1" OR ((clinic$5 OR committee$1) N/3 (advisor$4 OR practice$1)) OR (expert$1 N/3 (opinion$1 OR panel$1)) OR policy OR policies)) NOT (TI,DTYPE(conference$1 OR meeting$1 OR correct$5 OR errata OR erratum OR editor$1 OR editorial$1 OR comment$5 OR reply OR letter$1 OR response$1 OR correspondence$1 OR note$1) OR TI,AB,SU,DTYPE(case$1 N/3 (report$1 OR series OR stud$3)))	2807

Set#	Searched for	# Results
S11	S10 NOT (TI,AB(((animal$1 OR cell$4 OR computational OR ex-vivo OR in-silico OR in-vitro OR in-vivo OR laboratory OR non-clinical OR nonclinical OR transgenic) N/3 (experiment$1 OR model$4 OR stud$3 OR technique$1)) OR "cell line$1" OR rat OR rats OR murine OR murinae OR mouse OR mice OR gerbil OR gerbils OR "guinea pig" OR "guinea pigs" OR hamster OR hamsters OR rodent OR rodents OR rabbit OR rabbits OR hare OR hares OR dog OR dogs OR puppy OR puppies OR beagle$1 OR "german shepherd$1" OR "labrador retriever$1" OR "golden retriever$1" OR feline$1 OR cat OR cats OR kitten OR kittens OR monkey OR monkies OR monkeys OR baboon$1 OR macaque$1 OR simian$1 OR chimp$1 OR chimpanzee$1 OR orangutan$1 OR "non-human primate$1" OR "nonhuman primate$1" OR porcine$1 OR swine$1 OR pig OR pigs OR piglet OR piglets OR equine$1 OR horse OR horses OR bovine$1 OR cattle OR cow OR cows OR bull OR bulls OR goat OR goats OR ovine$1 OR sheep OR ram OR rams OR ewe OR ewes OR lamb OR lambs OR bird$1 OR chick$1 OR chicken$1 OR poult$2 OR zebrafish$2 OR "zebra fish$2"))	2424
S12	S11 AND PD(>=20040101) AND LA(English)	1804
S13	S12 AND TI(((HIV OR HIV1 OR HIV2 OR HIV-1 OR HIV-2 OR "human immune deficiency virus" OR "human immunodeficiency virus") N/2 (acute OR primary OR associated OR related OR disease$1 OR infect$4 OR syndrome$1 OR positive OR diagnosis)) OR "acquired immune deficiency syndrome" OR "acquired immunodeficiency syndrome" OR "HIV/AIDS" OR "human immune deficiency virus/acquired immune deficiency syndrome" OR "human immunodeficiency virus infection/acquired immunodeficiency syndrome" OR HIV OR HIV1 OR HIV2 OR HIV-1 OR HIV-2 OR "human immune deficiency virus" OR "human immunodeficiency virus")	341

Appendix B. List of Excluded Studies

Author Year	Title	DOI	Exclusion Reason
Capparé 2019	The 'All-on-four' protocol in HIV-positive patients: A prospective, longitudinal 7-year clinical study	https://pubmed.ncbi.nlm.nih.gov/31781702/	Outcomes not of interest
deTilly 2022	Review of Treatments for Oropharyngeal Fungal Infections in HIV/AIDS Patients	http://dx.doi.org/10.3390/microbiolres13020019	Narrative review with recommendations
Divyadarshini 2022	Clinical practice guidelines for oral health management in hiv patients	http://dx.doi.org/10.31838/hiv22.02.716	Narrative review with recommendations
Gherlone 2016	A Prospective Longitudinal Study on Implant Prosthetic Rehabilitation in Controlled HIV-Positive Patients with 1-Year Follow-Up: The Role of CD4+ Level, Smoking Habits, and Oral Hygiene	http://dx.doi.org/10.1111/cid.12370	Outcomes not of interest
Gonçalves 2004	Association of T CD4 lymphocyte levels and subgingival microbiota of chronic periodontitis in HIV-infected Brazilians under HAART	http://dx.doi.org/10.1016/j.tripleo.2003.08.023	Outcomes not of interest
Jordan 2006	Clinical treatment outcomes of periodontal therapy in HIV-seropositive patients undergoing highly active antiretroviral therapy	https://pubmed.ncbi.nlm.nih.gov/16820335/	Numeric data not available
Lemos 2010	Periodontal disease and oral hygiene benefits in HIV seropositive and AIDS patients	http://dx.doi.org/10.4317/medoral.15.e417	Outcomes not of interest
Lin 2024	Comparative efficacy of antifungal drugs for the treatment of oral candidiasis in HIV-positive patients: A Bayesian network meta-analysis	http://dx.doi.org/10.1016/j.medcli.2024.05.018	Intervention not of interest
Niazi 2020	Clinical efficacy of photodynamic therapy in the treatment of necrotizing ulcerative periodontitis among HIV seropositive patients: A randomized controlled clinical trial	http://dx.doi.org/10.1016/j.pdpdt.2019.101608	Outcomes not of interest
Nunes 2024	Antimicrobial photodynamic therapy in the nonsurgical treatment of periodontitis in patients with HIV infection: a systematic review and meta-analysis	http://dx.doi.org/10.1007/s10103-024-04087-y	Outcomes not of interest
Patton 2016	Current strategies for prevention of oral manifestations of human immunodeficiency virus	http://dx.doi.org/10.1016/j.oooo.2015.09.004	Narrative review with recommendations
Patton 2014	Progress in understanding oral health and HIV/AIDS	http://dx.doi.org/10.1111/odi.12220	Narrative review with recommendations
Robbins 2017	Recent Recommendations for Management of Human Immunodeficiency Virus-Positive Patients	http://dx.doi.org/10.1016/j.cden.2016.12.006	Narrative review with recommendations
Sabbah 2019	A retrospective analysis of dental implant survival in HIV patients	http://dx.doi.org/10.1111/jcpe.13077	Outcomes not of interest
Salgado 2017	Effect of photodynamic therapy with malachite green on non-surgical periodontal treatment in HIV patients: a pilot split-mouth study	http://dx.doi.org/10.1007/s10103-016-2083-8	Outcomes not of interest
Seminario 2024	Integrating Oral Health Within Kenyan HIV Research & Policy Structure: Stakeholder Analysis	http://dx.doi.org/10.5334/aogh.4150	Outcomes not of interest
Shetty 2006	Success of root canal therapy in HIV-positive patients	https://pubmed.ncbi.nlm.nih.gov/17134076/	Outcomes not of interest

Author Year	Title	DOI	Exclusion Reason
Zeng 2021	Efficacy and acceptability of different anti-fungal interventions in oropharyngeal or esophageal candidiasis in HIV co-infected adults: a pilot network meta-analysis	http://dx.doi.org/10.1080/14787210.2021.1922078	Intervention not of interest

Appendix C. List of Clinical Practice Guidelines Without Dental Care Recommendations

Professional Organization	Title	Year	Type of Publication	Reasons To Exclude
American Dental Association (ADA)	Human Immunodeficiency Virus (HIV)	Last updated 2023	Fact page	This is a general fact sheet on HIV and dental care, with notes on oral manifestations of HIV and recommendations for dental care management.
British HIV Association (BHIVA)	BHIVA Guidelines on Antiretroviral Treatment for Adults Living with HIV-1 2022 (2023 interim update)	2022/Updated 2023	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
British HIV Association (BHIVA)	BHIVA Guidelines for the Management of HIV in Pregnancy and Postpartum 2018 (2020 third interim update)	2018/Updated 2020	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
British HIV Association (BHIVA)	BHIVA Guidelines for the Management of HIV-2 2021	2021	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
Centers for Disease Control and Prevention	Sexually Transmitted Infections Treatment Guidelines: HIV Infection: Detection, Counseling, and Referral	2021	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
Centers for Disease Control and Prevention (CDC)	Recommendations for HIV prevention with adults and adolescents with HIV in the United States, 2014	2014	Recommendations	Relevant to HIV, but no oral health treatment or care advised or noted.
Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), and the HIV Medicine Association (HIVMA) of the Infectious Diseases Society of America (IDSA)	Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents: Recommendations from CDC, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America	2009	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
Department of Health and Human Services	Recommendations for the Use of Antiretroviral Drugs During Pregnancy and Interventions to Reduce Perinatal HIV Transmission in the United States	2024	Recommendations	Relevant to HIV, but no oral health treatment or care advised or noted.

Professional Organization	Title	Year	Type of Publication	Reasons To Exclude
DHHS Panel on Antiretroviral Guidelines for Adults and Adolescents – A Working Group of the Office of AIDS Research Advisory Council (OARAC)	Guidelines for the Use of Antiretroviral Agents in HIV-1-Infected Adults and Adolescents	2009	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
European AIDS Clinical Society	Major revision version 12.0 of the European AIDS Clinical Society Guidelines 2023	2023	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
Health Resources and Services Administration (HRSA) Special Projects of National Significance (SPNS) Innovations in Oral Health Care Initiative (Oral Health Initiative)	Module 5: Clinical Guide to Integrating Oral Care in the Medical Setting	2013	Learning module	Appears to be for continuous education, and if not excluded, would overlap with other recommendations.
Health Resources and Services Administration (HRSA)'s Ryan White HIV/AIDS Program	Optimizing HIV Care for People Aging with HIV: Putting Together the Best Health Care Team; Reference Guide for Aging with HIV	Unclear	Guide	Relevant to HIV, but no oral health treatment or care advised or noted.
Health Resources and Services Administration (HRSA)'s Ryan White HIV/AIDS Program	Optimizing HIV Care for People Aging with HIV: Incorporating New Elements of Care; Reference Guide for Aging with HIV	Unclear	Guide	Relevant to HIV, but no oral health treatment or care advised or noted.
Health Resources and Service Administration (HRSA)	Oral Health for People With HIV	2023	Fact page	This is a fact page for patients with HIV, and what dental symptoms they should watch out for, and what dental care they should seek out.
Health Resources and Services Administration (HRSA) Special Projects of National Significance (SPNS) Innovations in Oral Health Care Initiative (Oral Health Initiative)	Oral Health: Demonstration Model of Oral Health Care Highlights from the Special Projects of National Significance (SPNS) Program	2018	Fact sheet	This fact sheet describes oral health problems in HIV/AIDS patients. Referencing a specific intervention for oral health, 'Demonstration Model of Oral Health Care", evidence-based steps are given for replicating this model and providing oral health care services to people living with HIV/AIDS.

Professional Organization	Title	Year	Type of Publication	Reasons To Exclude
HIV Medicine Association of the Infectious Diseases Society of America & Infectious Diseases Society of America	Clinical Practice Guidance for Persons With Human Immunodeficiency Virus: 2020 Update by HIVMA/IDSA	2021	Guidance	Relevant to HIV, but no oral health treatment or care advised or noted.
International Antiviral Society	Antiretroviral Drugs for Treatment and Prevention of HIV Infection in Adults: 2022 Recommendations of the International Antiviral Society–USA Panel	2022	Recommendations	Relevant to HIV, but no oral health treatment or care advised or noted.
National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention	Integrated Prevention Services for HIV Infection, Viral Hepatitis, Sexually Transmitted Diseases, and Tuberculosis for Persons Who Use Drugs Illicitly: Summary Guidance from CDC and the U.S. Department of Health and Human Services	2012	Recommendations and reports	Relevant to HIV, but no oral health treatment or care advised or noted.
National HIV Curriculum	Lesson 2. Oral Manifestations	2024	Curriculum guide lesson	This is a lesson on oral manifestations seen in people with HIV, and specifically notes diagnostic procedures that can be used when evaluating HIV-related oral lessons, and appropriate treatments. It appears to be intended for all health providers.
National Institute of Dental and Craniofacial Research	HIV/AIDS & Oral Health	Last updated 2024	Fact page	This is a general fact page on oral health in HIV/AIDS patients, describing oral health problems such as canker sores, herpes, hairy leukoplakia, candidiasis, and warts, and potential treatments.

Professional Organization	Title	Year	Type of Publication	Reasons To Exclude
National Institutes of Health, the Centers for Disease Control and Prevention, and the HIV Medicine Association of the Infectious Diseases Society of America Panel on Guidelines for the Prevention and Treatment of Opportunistic Infections in Adults and Adolescents With HIV—A Working Group of the NIH Office of AIDS Research Advisory Council (OARAC)	Guidelines for the Prevention and Treatment of Opportunistic Infections in Adults and Adolescents With HIV	2024	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
New York State Department of Health and AIDS Education & Training Center Program, Northeast/Caribbean	Oral Health Affects Your Whole Body: It's an Important Part of Your HIV Care	2020	Brochure	This is a brochure intended for people with HIV, and what oral symptoms to look out for.
U.S. Department of Health and Human Services	Guidance for Non-HIV-Specialized Providers Caring for People With HIV Who Have Been Displaced by Disasters (Such as a Hurricane)	2024	Guidance	Relevant to HIV, but no oral health treatment or care advised or noted.
U.S. Department of Health and Human Services	Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents With HIV	2024	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
U.S. Department of Health and Human Services, Health Resources and Services Administration, HIV/AIDS Bureau	A Guide to the Clinical Care of Women with HIV, 2013 Edition	2013	Guide	Relevant to HIV, but no oral health treatment or care advised or noted.
The Well Project	HIV and Your Mouth	2023	Fact page	This is a fact page for patients with HIV, and what dental symptoms they should watch out for, and what dental care they should seek out (i.e. not speaking to clinical providers).
WebMD	HIV-Related Mouth Sores: Symptoms and Treatments	2022	Noted as guide, but looks like a fact page	This is a short guide for patients with HIV regarding mouth sores in HIV patients, symptoms and potential treatments.

Professional Organization	Title	Year	Type of Publication	Reasons To Exclude
World Health Organization (WHO)	Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach	2021	Guidelines	Relevant to HIV, but no oral health treatment or care advised or noted.
World Health Organization (WHO)	Antiretroviral Therapy for HIV Infection in Adults and Adolescents: Recommendations for a Public Health Approach	2010	Recommendations	Relevant to HIV, but no oral health treatment or care advised or noted.

Appendix D. Risk of Bias Assessments

The three included studies are single-arm studies. Therefore, we used the Newcastle Ottawa Scale to assess their risk of bias, as shown below.

Domain	Corresponding Components	Nobre 2019	Noro Filho 2013	Valentine 2016
1. Selection	1.1 Representativeness of the exposed cohort	0	0	1
	1.2 Selection of the nonexposed cohort	NA (single arm)	NA (single arm)	NA (single arm)
	1.3 Ascertainment of exposure	1	1	1
	1.4 Demonstration that outcome of interest was not present at start of study	1	1	1
2. Comparability	2.1 Comparability of cohorts on the basis of the design or analysis	NA (single arm)	NA (single arm)	NA (single arm)
3. Outcome	3.1 Assessment of outcome	1	1	1
	3.2 Was follow-up long enough for outcomes to occur?	1	1	1
	3.3 Adequacy of follow up of cohorts	1	1	0 (high dropout %)
Overall	**Overall Risk of Bias**	High	High	High